Changing Faces – Factors Influencing the Roles of Researchers in Real-World Laboratories

Annaliesa Hilger, Michael Rose, Matthias Wanner

In real-world laboratories (RwLs), researchers do more than conventional research. They slip into different roles. Why do they "change faces"? Based on comparisons of three urban RwLs, we analyse the process steps and conditions influencing the choices made by researchers to adopt certain roles.

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Abstract

Real-world laboratories (RwLs) often put researchers in highly demanding research contexts regarding their roles and self-conceptions. Helpful roles of researchers have been described but still little is known about the factors influencing the adoption of certain roles. Using data from three parallel RwLs in Wuppertal, Germany, we found four roles of researchers: *the reflective scientist, the facilitator, the change agent* and *the (self-)reflexive scientist.* We sequenced the RwLs into situations and analysed them by RwL process steps and conditions, considering the roles of researchers as outcomes. Although the conditions convey only limited explanatory power, there was a consistent picture that being pressured to carry out real-world action, having a practice partner with fewer resources and working without a functional project group is (in conjunction) sufficient to cause the researcher to partake in activities beyond conventional research. Process steps played a minor role. Our research on factors influencing the adoption of roles may help RwL researchers to perform their roles as intended.

Keywords

Qualitative Comparative Analysis, real-world laboratories, real-world laboratory flowchart, roles of researchers, transdisciplinarity, transformative research, Wuppertal

Recent studies on real-world laboratories (RwLs) emphasise the transformative character of the approach (Wanner et al. forthcoming, Schäpke et al. 2018, Schneidewind et al. 2016, Wagner and Grunwald 2015). Wanner et al. (forthcoming), for example, list eight constitutive principles including real-world interventions or "experiments" (box 1).[1] Consequently, researchers in RwLs are not only requested to observe, describe and analyse, but also to initiate and catalyse socio-ecological transformations, often even to lead the RwL process (Wagner and Grunwald 2015, Jaeger-Erben et al. 2018, in this issue).[2] Therefore, competent dealing with challenges such as power plays, knowledge integration, sustainability and action is crucial (Pohl et al. 2010, Wittmayer and Schäpke 2014). Researchers respond to the challenges by adopting several roles to maintain a balanced process. These roles and activities extend beyond the traditional scientific scope. Hence they require specific skills and training and curtail the resources available (especially time) for conventional research activities.

Up to now, little is known about the factors which influence researchers in their decisions to adopt certain roles in order to guarantee a satisfactory process. This research gap is significant, as the roles adopted by researchers have profound effects on the science-practice interaction, the outcome and the societal context (Wittmayer and Schäpke 2014).

Our research objective is therefore to analyse *which factors – that is, which process steps and conditions – influence the choices made by researchers to adopt certain roles*. In our study, the role chosen by the researcher is regarded as the outcome to be explained (explanandum). Since RwLs are mostly initiated by scientific institutions, we focus here solely on the researchers, construing the collaborating and participating actors as part of the conditions.

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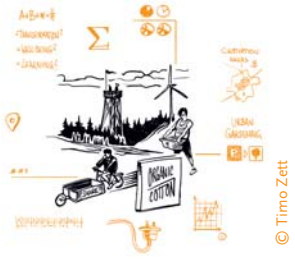
Labs in the Real World: Advancing Transdisciplinarity and Transformations

At the science-society interface, new forms of experimental and transdisciplinary research approaches, so-called society-based laboratories, have been established to accelerate transformations towards more sustainable societies. The *GAIA* special issue ***Labs in the Real World: Advancing Transdisciplinarity and Transformations,*** funded by the Ministry of Science, Research and Arts Baden-Württemberg and published in March 2018, brought the growing international research community together and presented a large variety of empirical and theoretical investigations that discuss questions such as the transformative potential, the overarching conceptualization as well as dimensions of transdisciplinarity and learning of such labs. In order to advance the expanding field of research on laboratories in real-world contexts, further articles complementing the special issue will appear in *GAIA*.



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Insights from three district RwLs in Wuppertal (Germany) are used as empirical material. Firstly, we elaborate on concepts of roles and influencing factors. Secondly, we present our research design, which includes a brief introduction of the RwLs and methodology used. Thirdly, we present the results of our study, followed by a discussion of the implications for future RwL research and practice.

Concepts of Roles and Influencing Factors

As outlined above, the transformative character of RwLs goes along with a wide spectrum of different researchers' activities, described as roles. Roles are characterised as follows (Wittmayer et al. 2016, Wittmayer and Schäpke 2014, Stoecker 1999):

- Roles are socially constructed, purposefully adopted, can be negotiated and thus change over time.
- One person might fulfil several roles, and numerous actors might embody identical roles.
- Roles overlap and vary according to individual performance.

In research literature, several roles are discussed, for example, in the context of transdisciplinary structured cases (Pohl et al. 2010), sustainability transitions (Wittmayer and Schäpke 2014), or participatory research (Stoecker 1999). Guided by the specific characteristics of RwLs, we found four roles, which are described in the following (for an attribution of researchers' activities to roles see for more detail table 2, p. 143 below).

Within the role of the *reflective scientist,* the researchers' activities are identical to conventional research activities as the role comprises the provision of scientific expertise. Furthermore, researchers analyse the RwL process and actors (Scholz 2011, Pohl et al. 2010). Thus, in this role researchers consider RwLs as an object of study and contribute at the same time with their expertise to the transformation. The *reflective scientist* role is close to the WBGU's (German Advisory Council on Global Change) characterisation of an RwL researcher as having "an ability to reflect and evaluate which (...) is disengaged from praxis" (WBGU 2016, p. 512).

As scientific institutions quite often initiate and lead an RwL process, researchers also act as a *facilitator*. In this role, the researcher initiates, shapes and fosters the collaboration and encourages expressions of all viewpoints (Scholz 2011, Pohl et al. 2010). Acting as a *facilitator,* the researcher enables transdisciplinary integration (Jahn et al. 2012) which is beneficially for cyclical learning processes.

When addressing the aims of RwLs to bring about transformations, we have to consider the role of the *change agent*. Here, the researcher stresses the importance of the process, and motivates and empowers participants (Wittmayer and Schäpke 2014). The inspiration for this role comes from (participatory) action research, where the science-practice interactions are characterised by the empowerment of participants (Ozanne and Saatcioglu 2008). In RwLs, the role of the *change agent* aims to achieve further capacity building and the realisation of the intervention(s). >

BOX 1:

Eight Key Components of Real-World Laboratories

suggested by Wanner et al. (forthcoming)

1. normative framing: aiming to contribute to sustainable development (see table 1, p. 141)
2. production of systems-, target- and transformation knowledge (mostly contextualised)
3. real-world problems as a starting point
4. boundaries: "Laboratory" demarcations, defined by content and space
5. transdisciplinary collaboration (co-leadership) with clear roles for practice and science
6. real-world intervention (often called "experimentation")
7. cyclical learning processes through reflection and variation
8. empowerment of change agents and capacity building

1 Parodi et al. (2016) and Schäpke et al. (2018) propose fewer RwL key characteristics on a more general level; the former normativity, transdisciplinarity, transformativity, orientation to civil society and long-term research infrastructures, the latter contribution to transformation, experiments as core research method, transdisciplinarity as core research mode, long-term orientation, scalability and transferability of results as well as learning and reflexivity.

2 This might be due to the structure of funding schemes directly targeting scientific institutions. See, for example, the RwL funding schemes by the Ministry of Science, Research and Arts in the German state of Baden-Württemberg (Wagner and Ertner 2016).

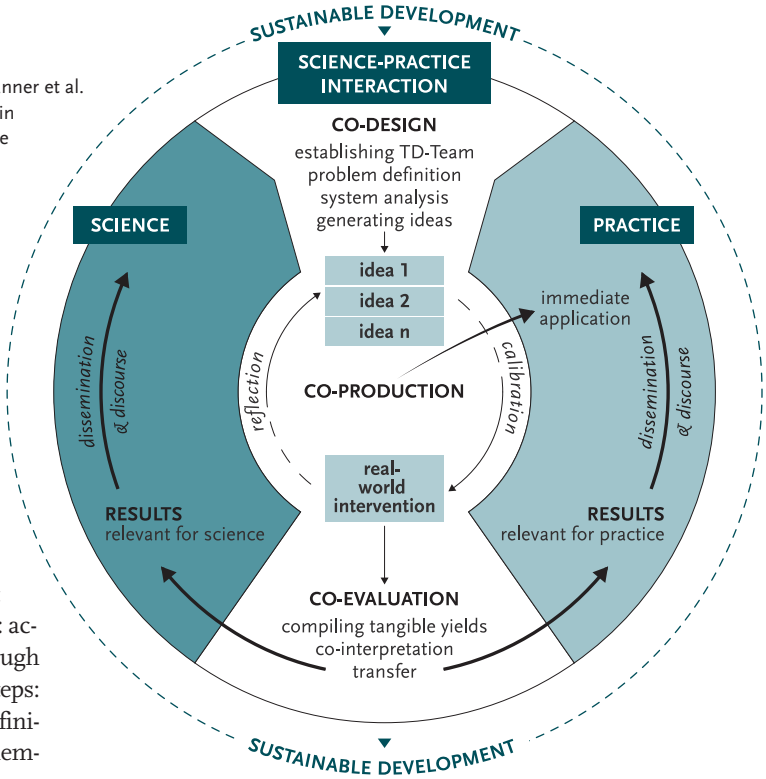


FIGURE 1: Flowchart for Wuppertal's real-world laboratories (RwLs) (Wanner et al. forthcoming). The transdisciplinary and transformative research process in RwLs comprises co-design, co-production and co-evaluation. At the centre of the process, real-world intervention(s) are developed and carried out.

In RwLs, researchers, moreover, face the challenge of conducting research within a normative framing and sometimes blurred lines between the object and the subject of research. It is therefore valuable to supplement the roles outlined above with the role of the *(self-) reflexive scientist*. In this role, researchers reflect on how their personality and values as well as internal and external power dynamics might influence the process (Wittmayer and Schäpke 2014).

Process Steps

The three RwLs studied are oriented towards the flowchart recently proposed by Wanner et al. (forthcoming) (figure 1): actors from science and practice form a team and proceed through three phases. The first phase, co-design, is divided into four steps: 1. establishing a transdisciplinary team (TD Team), 2. joint definition and representation of the problem, 3. analysing the problem-relevant system, defined by content and space, and 4. jointly generating ideas for intervention(s) targeting the problem. The second phase, co-production, comprises two distinguishable steps: 5. initiating a real-world intervention, that is, real-world experiments in the chosen field, and 6. continuous reflection on the intervention and re-calibration of actions, if necessary. In the third phase, co-evaluation, the project team 7. compiles the tangible yields of the co-design and co-production phase, 8. co-interprets the products and outcomes and 9. transfers the learning into the respective practical or scientific field. It is plausible to assume that the different process steps require the adoption of different role emphases: for example, Lang et al. (2012) described different challenges per process step which require different activities from researchers.

Conditions for the Choice of Certain Roles

In the following section, four conditions identified in the literature and in our empirical material are introduced:

Resources are a crucial condition. This applies to both practitioners and researchers, and includes staff, time and financial resources (Scholz and Steiner 2015a, Schauppenlehner-Kloyber and Penker 2015, Carew and Wickson 2010). In situations when the process builds on practitioners' engagement "in the field", scarce resources on the part of the practice partner can induce the researcher to assume an action-oriented role in order to compensate it (Rose et al. 2017, Nevens et al. 2013).

Secondly, the situationally adequate ***experience and knowledge*** (including skills) of the researcher during the different phases and steps of an RwL may condition the processes and roles (Carew and Wickson 2010, Stoecker 1999).

Furthermore, the level of group organisation ***(project group)*** influences the roles adopted by RwL researchers, as researchers quite often fulfil roles that are not occupied by others (Schauppenlehner-Kloyber and Penker 2015, Stoecker 1999).

Finally, different ***expectations*** might lead to conflict, which generally reveals itself during the problem definition (Jahn et al. 2012). The external pressure on researchers to directly apply interim results is particularly problematic (Scholz and Steiner 2015b, Avelino 2009).

Research Design

The Wuppertal Real-World Laboratories

For our comparative case study, we draw on three RwLs located in three districts of the city of Wuppertal, Germany. The districts are similar in terms of their heterogeneous socio-economic composition. All RwLs were established in spring/summer 2015, since when they have been running in parallel. The scientific operation of the RwLs is ensured by having one early-stage researcher in each RwL. However, the RwLs differ from each other in terms of their thematic focus, type of practice partner and the specific situation at the outset of the RwL process (Rose et al. 2017).

The first RwL, located in the districts of Oberbarmen and Wichlinghausen, focuses on permanently untenanted apartments and develops and tests concepts for low-threshold vacancy reduction. The practice partner, the *Büro für Quartierentwicklung (Agency for District Development)*, is a small semi-public local association with

TABLE 1: Guiding questions for detailed case descriptions. The questions focus on the viewpoint of the researcher. They were developed by joint reflection of the three real-world laboratory researchers and project lead.

MAIN POINT	QUESTIONS
process steps	■ What distinct process steps exist in the RwL process?
interactions: activities undertaken by me and other actors (the group/the practitioner)	■ Who were the relevant actors within these process steps? ■ What did these actors do? ■ How did their actions interact with mine? ■ Who initiated and moderated the meetings/activities?
positions: power within the process	■ Who decides on topic, process steps, agenda setting? ■ Did someone attribute the tasks ("give orders")? ■ Who decides on the process (horizontal vs. vertical)?
expectations	■ What were the relevant expectations (mine, the practitioner's, the project lead's)?
context: institutions and structures	■ What institutions influence me (laws, norms and values, culture, science system)? ■ What is the setting of the RwL (practitioners' legal form, local context)?
material and intangible resources (not including personality)	■ What resources were available to the collaborating actors (practitioners, researchers, others)? ■ What additional resources were brought in (trainees, funding, service learning)?

scarce resources. The second RwL in the district of Arrenberg works with the young civil society group *Essbarer Arrenberg (Edible Arrenberg)*, a subgroup of *Aufbruch am Arrenberg (Arrenberg Starts Out)*, which is driven by entrepreneurial commitment to making Arrenberg a climate-neutral district. The RwL promotes sustainable, locally-sourced food for the district, partly by supporting the development of a corresponding strategy. In the district of Mirke, the third RwL focuses on a forum for bottom-up participatory district development and on establishing a co-research group in the district. The researcher here collaborates closely with two representatives from *Utopiastadt (Utopia City)*, a local charitable organisation characterised by its creative, culture-related, green alternative milieu.

Analytical Steps, Methods and Data

We employ a research design unique in current RwL research. Our constellation of comparable empirical RwLs allows us to make both diachronic within-case comparisons and synchronic cross-case comparisons. Both are analysed in two ways using qualitative approaches. Our analysis starts with descriptive work and progresses to a Qualitative Comparative Analysis (QCA) (Ragin 1987, 2000).

The initial data for our analysis are detailed sequential case descriptions with dichotomised information on situations (rows) and conditions and roles (columns). Thus, for every RwL, the ongoing science-practice interaction was chronologically broken down into specific situations (38 in total), using the steps 1 to 6 from the flowchart outlined above (see figure 1). Steps 7 to 9 are not yet complete and therefore not included. The data is based on discussions in workshops, on research diaries, on observation protocols and on interviews. We involved all RwL researchers, the project lead and sought the practice partners' views (via interviews). Table 1 lists the questions that guided the detailed case descriptions.

For every situation, we focused on researchers' activities and assigned respective roles to the researchers, as described by Wittmayer and Schäpke (2014). We extracted and operationalised those conditions that have been shown to influence the adoption of roles in the literature (see section on concepts of roles above) and from first inductive insights of the cases. The conditions were calibrated, which guided the dichotomisation of the data (for our calibration rules, see online supplement *[SM]*, table C)[3]. The analytical steps are listed in box 2 below and more detailed in *SM*, table A[3].

In our descriptive work, we reduced, adapted and specified the initial role understandings to the reality of our cases. Furthermore, we analysed distributions and visualised relationships between the roles from the data table (see *SM*, table J)[3], in order to identify possible patterns or correlations in the chosen roles in relation to RwL phases.

To systematically analyse the causal relevance of certain conditions to the roles chosen by researchers, we conducted several crisp-set Qualitative Comparative Analyses (cs/QCAs). QCA allowed us to identify necessary and sufficient (conjunctions of) conditions for the respective outcome (occurrence of a particular role). >

3 The supplementary material is available at *https://www.oekom.de/supplementary-files.html#c12045*.

BOX 2: Main Steps of Analysis

1. joint reflection and definition of guiding questions for case descriptions
2. detailed sequential case descriptions
3. analysis of activities and deductive identification of roles
4. inductive reduction, adaptation and specification of roles
5. extraction and operationalisation of conditions
6. calibration of the conditions
7. descriptive analysis
8. identification of necessary and sufficient (conjunctions of) conditions for the respective outcome with Qualitative Comparative Analysis (QCA)

For more details see *SM*, table A.[3]

It is suitable for mid-n (≥10) and large-n sets of cases and a research interest in conjunctions of causal conditions, allowing for equifinal causality regarding the resulting outcome (Schneider and Wagemann 2012). Despite its systematising, formalising and to some extent quantifying features, QCA is above all a qualitative research approach, which keeps a close focus on individual cases.[4]

Moreover, we created one fuzzy-scaled (fs) outcome, which we called "partaking". Here, we merged the different occurring roles into one single outcome by focusing on how much the researcher partakes in activities beyond conventional research. The "partaking" dimension is present to varying degrees in all four roles. For example, acting as a *change agent* means full membership in the set of partaking, whereas acting as a *(self-)reflexive scientist* means full non-membership. Data sets, calibration rules, truth tables, solution terms and consistency and coverage measures are provided in the *SM* both for cs/QCAs and the fs/QCA (see *SM,* tables B–D and H–M)[3].

Results

Results from the Descriptive Analysis

Activities and Roles in Real-World Laboratories

The detailed sequential case descriptions reflect activities described in the literature but also reveal additional activities which are slightly different and which expand the previous understandings. This is especially true for the role of the *change agent* due to the RwLs' focus on interventions (mirrored in key component 6). Therefore, we complemented and specified the roles to make them suitable for (our) RwL settings (table 2).[5]

Distribution of Roles within and across Real-World Laboratories

In Wuppertal's RwLs in general, there was only little variance regarding the frequency with which the roles were adopted by the researchers (see *SM,* figure A)[3]. A detailed analysis reveals that the *(self-)reflexive scientist* role was present to some degree in almost every situation but was often not the researcher's main role. However, the *(self-)reflexive scientist* role came to the fore in situations where the researcher perceived challenges such as power imbalances. It is also a role into which the researcher withdrew if other activities were not appropriate in a certain situation.

However, when considering each RwL separately it stands out that the *(self-)reflexive scientist* role was adopted more often in the Arrenberg RwL than in the other RwLs, and the *change agent* role was embodied more frequently than average in the Oberbarmen/Wichlinghausen RwL (see figure 2).

Roles along the Real-World Laboratory Process

The process steps were not always taken chronologically. However, it does not affect our analysis as our cases are based on situations (and not on their succession). Our expectation that the RwL process steps would correlate with the roles adopted by the researchers was, with a few exceptions, not met. The greatest differences in roles adopted were seen within the co-design phase (see *SM,* figure B)[3]: especially the TD team set-up stages are characterised by high expectations of the collaborating actors, sometimes resulting in conflicts which require activities such as reflection on group-building processes, internal and external power dynamics and normative orientations. This explains why the *(self-)reflexive scientist* was most prominent in the first co-design phase. The researcher adopted also the *change agent* role at the beginning of the co-design phase rather than at the end; the role of the *change agent* is almost as often carried out during the intervention and reflection/calibration phases as in the first co-design phase. The *reflective scientist* was – similar to the *facilitator* – most frequently present in the second co-design phase, since here the joint production of knowledge comes to the fore.

Conditions and Roles in Real-World Laboratories

In the Mirke RwL, the researcher adopted all four roles with a similar frequency. The RwL was characterised by *low resources* in terms of time contributed to the respective situations by the practice partner and *little external pressure* on the researcher to carry out real-world action. The Oberbarmen/Wichlinghausen RwL faced *high external expectations* to perform real-world action, had very *limited resources* on the practice partners' side and often *lacked a functional project group*. This goes along with the quite frequent adoption of the *change agent* role and the *facilitator* role. In contrast, the Arrenberg RwL had an *established and functional project group, substantial resources* contributed by the practice partners and, most of the time, faced *low external expectations* to carry out real-world action. Here, the role of the *(self-)reflexive scientist* was frequently adopted.

Results from Qualitative Comparative Analyses[6]

Necessary Conditions

Across all QCAs, only one necessary condition was identified: having *situationally adequate knowledge*. This condition was necessary for the roles of the *reflective scientist* and *facilitator* and tended to be easily met, as it existed in 82 percent of all cases. It is notable that for the *(self-)reflexive scientist,* this condition only occurred in half of the cases, which means it is "least necessary" for the latter role.

Sufficient (Conjunctions of) Conditions for the Choice of the Four Roles

The tests for sufficient conditions also produced only a few valid results (due to inconsistent truth table rows), which means the analysed conditions convey rather weak explanatory power. However, we found that a combination of three conditions resulted in the researcher choosing the *change agent* role (sufficient conjunction of conditions): when the practice partner contributed *fewer*

4 Length restrictions do not allow for an introduction to QCA. We refer to the leading textbook on set-theoretic methods, Schneider and Wagemann (2012).

5 We found no activities exclusively relating to the role of an *intermediary/knowledge broker,* which is also described in the literature (Pohl et al. 2010, Wittmayer and Schäpke 2014). Thus, for our study, a clear-cut distinction between an *intermediary's* and *facilitator's* activity seemed unnecessary. Consequently, we included mediation activities in the *facilitator* role, following (among others) Scholz and Steiner (2015 b) and Fischer and Newig (2016).

TABLE 2: Activities and roles in Wuppertal's real-world laboratories (RwLs). Activities of researchers in the studied RwLs go beyond those described in literature.

ROLE	ACTIVITIES (adapted from Wittmayer and Schäpke 2014)	ACTIVITIES (added from the RWL studied)
reflective scientist	■ analyse dynamics and actors ■ provide knowledge on the basis of analysis ■ analyse outcomes ■ observe, reflect and analyse actions	■ investigate application-oriented knowledge (e. g., legislation, best practice etc.) ■ reflect on the intervention, possibly with regard to existing academic knowledge (e. g., unexpected outcomes)
facilitator	■ initiate and facilitate (learning) process and experiment ■ select participants ■ encourage expressions of all viewpoints	■ balance different interests and actor dynamics ■ mediate between different perspectives and viewpoints ■ provide space for critical reflection
change agent	■ motivate and empower participants to lead/own the process ■ network with stakeholders outside the group ■ participate in process and experiments	■ motivate and empower participants to own a project ■ establish working structures ■ develop tools and recommendations ■ initiate an intervention ■ coach and consult collaborating actors
(self-)reflexive scientist	■ engage in a (self-)reflexive practice with regard to own normative orientation ■ engage in a self-reflexive practice with regard to internal and external power dynamics	■ write observation protocols and research diaries (participate and observe)

resources to the respective situation than the researcher, when there was *no established or functional project group*, and when the researcher was *pressured to carry out real-world action*. This was observed in the Oberbarmen/Wichlinghausen RwL. On the other hand, the decisive combination of conditions for not choosing the *change agent* role was situationally adequate knowledge and *low external expectations to perform real-world action*. Equally, not choosing to act as a *(self-)reflexive scientist* was influenced by having *situationally adequate knowledge* and comparably *few resources* contributed by the practice partner. This was especially true when combined with *low pressure to carry out real-world action* or, more often, with a *not yet established or dysfunctional project group*.

Sufficient (Conjunctions of) Conditions for Researchers' Partaking

Being *pressured to carry out real-world action* and having a *practice partner contributing fewer resources* than the researcher and working *without an established or functional project group* is (in conjunction) sufficient to cause the researcher to partake in activities beyond conventional research. The first two of these conditions were the most decisive. This causal relation is consistently present in the Oberbarmen/Wichlinghausen RwL.

Results from a Second Look on the Data

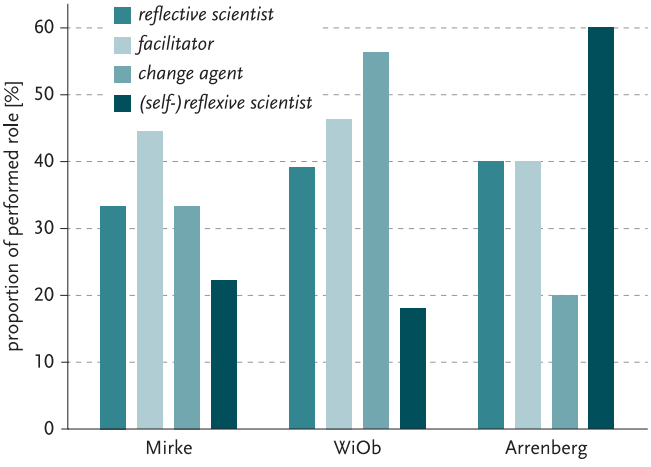
A qualitative reflection on the detailed sequential case descriptions reveals further findings, which need more systematic empirical research in the future based on a larger number of cases.

In general, the RwLs are strongly driven by the fixed and very small TD teams: the roles of the researchers are therefore far more dependent on the respective practice partner and his or her activities than on the general dynamics of the RwL process, which may be a specific criterion of the Wuppertal RwLs.

As the data indicates, researchers tended to adopt the role of a *change agent* in situations with an *unclear future prospect* of the RwL, such as a volatile commitment of the practice partner, or an intervention with a significant risk of failure. Reflecting our results on resources, especially in situations with an *asymmetric relation between the practitioners' and researchers' amount of resources* (especially time), two poles of a continuum became visible: in situations where the researcher could contribute more resources than the practice partner, researchers tended to adopt rather active roles (such as the *change agent*), whereas researchers tended to withdraw from real-world action in situations where the practice partner contributed more resources. However, the respective relative amount of contributed resources was neither necessary nor sufficient for adopting a particular role (see results from QCA above).

The appreciation of scientific contributions in the RwL process depended on the *practitioners' expectations*, which were most- >

FIGURE 2: Distribution of roles within Wuppertal's real-world laboratories. Note: Cases can display more than one main role at the same time. The percentages show the proportion of situations in which the role was performed.



6 See *SM*, tables H–O, for details.[3]

ly raised at the beginning of the co-design. Disparate expectations were observed in the Arrenberg case, where the practice partner expected additional manpower capacity rather than scientific expertise and reflection, resulting in less space for the adoption of the *reflective scientist* role. Researchers had a certain leeway for adopting different roles when a long-term science-practice relationship already existed. An example is the case of Mirke, where a good personal relationship existed prior the RwL process (Rose et al. 2017).

Overall, in situations with a rather low level of interpersonal tensions, researchers tend to align their activities to the working routines of the RwL; whereas situations with strong tensions (e.g., due to clashing personalities or expectations) resulted in the withdrawal of both sides. As observed in the case of Arrenberg, changes in the configuration of the RwL team, such as entering or leaving the RwL process, reduced the tensions and allowed affected parties to vibrantly re-enter the RwL process.

Between Action and Reflection – Shaping Influencing Factors Purposefully

We elaborated on factors influencing researchers to adopt certain roles that enable researchers not only to perform research but also to initiate and catalyse transformations. Our study seeks to contribute to the need to reflect on our own roles within RwL processes (Nowotny 2018, Schneidewind et al. 2016). Furthermore, by focusing on roles and activities we wish to contribute to a differentiated view of researchers' reality in RwLs and thus to a profound self-reflection of RwL praxis.

Starting with the limitations of the study, we found fewer causal conjunctions than expected. Causally decisive conditions seemed to be missing. A plausible further condition not yet considered is personality (see the last section and Miah et al. 2015, Carew and Wickson 2010). Internal motivations or gender may affect the researcher's choice of role as well. Our analysis is furthermore limited by the medium number of cases and the close link to the Wuppertal context. Consequently, caution should be taken in generalising our results. It would be beneficial to substantiate our results by examining RwLs in other cities. We encourage larger-n research designs and the further use of QCA and related techniques. Future research could also include not only more cases and conditions, but also an analysis of the characteristics and interactions between all the involved actors' roles (Wittmayer et al. 2016), including the practitioners' roles and role changes.

Nevertheless, our study with its sound empiricism contributes to both underlining and questioning existing assumptions and suggestions. In the literature, for example, we find descriptions of certain requirements and challenges per process step from transdisciplinary processes (Lang et al. 2012) but our empirical findings reveal only a slight link between certain process steps and roles. A difference of roles, though, was found within the co-design phase: at its start, the researchers tended to adopt the *change agent* role, as activities such as motivation and empowerment are useful during the setup of a TD team. At its end, usually the *facilitator* role was assumed, as its activities are useful to foster workshops. Nevertheless, there is no specific role which necessarily goes with a certain process step. Performed activities rather seem to follow given circumstances and (short-term) real-world demands. A big portion of flexibility and adaptability is therefore demanded from RwL processes as clear sequences of roles can only be expected to a limited extent.

Our research also suggests that in the Wuppertal RwLs the role of the *(self-)reflexive scientist* was often chosen as a retreat option when all other activities were not possible or not desired (see results from descriptive analysis). Being a *(self-)reflexive scientist* as a complementary activity might still contribute to a better understanding of the processes observed. Clear communication with all practice partners helps to avoid asymmetric expectations and frustration, which may also help to deal with a particularly challenging conjunction of conditions: 1. fewer *resources* contributed by the practice partner, 2. *pressure* to carry out real-world action, and 3. a non-functional *project group*. As one of our main findings, such a conjunction results in the adoption of the *change agent* role. Performing the *change agent* role seems to be the "active" way out of the tense situation while a terminal withdrawal from the whole setting could theoretically have been the consequence of this conjunction, too.

All things considered, we suggest to sensibly establish (or adjust) an RwL team, being aware of the skills, competences, qualifications and status necessary for certain roles. We also wish to raise awareness for settings with limited staff and resources where the frequent adoption of partaking roles might go hand in hand with fewer resources left for conventional research activities. To avoid such a trade-off, the high resource requirements should be taken into account when establishing new RwLs. The consequence might be to choose purposefully and informed RwL settings. It depends on the intention of the researchers to what extent the respective roles should be performed. For example, the decisive conjunctions of conditions leading to the absence of the *change agent* role are *situationally adequate knowledge* and *low external pressure to perform real-world action*. A further strategy to save resources would be to "jump on the bandwagon" of an already existing project group (Rose et al. 2017).

We are therefore very much in line with Helga Nowotny (2018) who stresses that transdisciplinary and transformative research endeavours are fruitful, but need regular, structured and well-resourced spaces for training of and reflection on the various roles.

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